Masters of the Environment
University of Colorado **Boulder**

SUSTAINABILITY & COMMUNITY RESILIENCY STRATEGIES FOR WILLOUGHBY CORNER

PREPARED FOR BOULDER COUNTY HOUSING AUTHORITY
BY THE MASTERS OF THE ENVIRONMENT
URBAN RESILIENCE AND SUSTAINABILITY CLINIC

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TABLE OF CONTENTS

INTRODUCTION

The Boulder County Housing Authority (BCHA) is developing and designing Willoughby Corner, a 24-acre affordable housing project, in Lafayette, Colorado. The planned community is the product of an intergovernmental agreement between the City of Lafayette and Boulder County that has dedicated the land to create deed-restricted, permanently below-market rate housing that includes both rental and for-sale options. In addition to providing affordable workforce housing, BCHA is interested in developing sustainability strategies that promote climate-friendly, resilient, and inclusive principles throughout the community. In collaboration with the University of Colorado Boulder's Masters of the Environment program, a group of graduate students in the Urban Resilience and Sustainability Clinic course have developed this report of recommendations to support BCHA's vision for Willoughby Corner.

In this report, strategies for the following topic areas are outlined:

- Solar installations and facade
- Agrivoltaics
- EV charging stations
- Dispersed bike storage and kiosks
- Bus stop infrastructure
- Site lighting
- Art installations
- Site signage
- Community gardens, landscaping, plaza and trail features
- Playgrounds, dog parks, recreation trails, and orchards
- Sustainable materials

Click here to access the Pinterest board that includes additional design considerations.

GLOSSARY

Agrivoltaics
Curtain Wall
Hostile Architecture
Micromobility
PV Integrated
Solar Facade

ACRONYMS

BCHA - Boulder County Housing Authority
CU Boulder - University of Colorado Boulder
EV - Electric vehicle
MENV - Masters of the Environment
NZE - net-zero energy
PV - Photovoltaic
URS - Urban resilience and sustainability

WILLOUGHBY CORNER CONTRIBUTORS

Dispersed bike/mail/bulletin kiosks | Boulder County Mobility for All, Boulder County Community Planning & Permitting, HB&A
Bus stop infrastructure | Boulder County Mobility for All, HB&A, Kimley-Horn, RTD
EV charging stations | Boulder County Mobility for All, HB&A, Farnsworth
Site lighting | Norris Design, Farnsworth, HB&A, City of Lafayette
Art installations | Norris Design, Farnsworth, HB&A, City of Lafayette, ELAC
Site signage | Norris Design, Farnsworth, HB&A
Community gardens, landscaping, plaza, trails | Norris Design, KH, HB&A, ELAC
Playground, dog park, recreation trail, orchards | Norris Design, KH, HB&A, ELAC
Solar installation & façade | Norris Design, HB&A
Agrivoltaics | Norris Design, HB&A
Sustainable materials | HB&A, Group 14

RTD - Regional Transportation District
ELAC – East Lafayette Advisory Committee
HB&A – Architect
Kimley-Horn (KH) - Traffic Engineer
Norris Design - Master Planner & Landscape Architect
Farnsworth - MEP & Structural Engineer
Group14 - Sustainability & Enterprise Green Communities

SOLAR INSTALLATIONS & FAÇADE

Solar installations are becoming increasingly popular, as renewable energy does not produce GHGs and it contributes to grid resiliency and energy security. Often, rooftop solar on its own cannot completely offset a building's energy use. A building trying to achieve net-zero energy (NZE) might purchase offsite solar or place ground-mounted panels in addition to rooftop units. As available space decreases with development, developers can integrate alternative solar designs into a building plan. Such alternatives include: solar sunshades or overhangs, a solar curtain wall, agrivoltaics, or solar carports. Solar carports provide renewable energy without occupying surrounding space, while protecting vehicles from weather and harsh sun. Solar curtain walls are more cost effective in new construction or major renovation, as the use of the panels as an exterior façade eliminates the need for outside cladding. They are not as cost effective when applied directly to an existing building. Solar curtain walls must also be installed properly to operate efficiently and for longevity.

01. Installation Type

Solar awnings, pergolas, and overhangs will provide an aesthetically pleasing community space for residents to enjoy, protecting them from the elements and providing shade. Awnings and overhangs can also reduce the emissivity of a window, providing passive cooling to the building's internal space. Individual carports can be linked to EV charging stations to create solar EV charging stations.

02. Positioning and Production

For tilted installations, consider the cardinal direction of the proposed solar modules; west to south-facing panels are most productive, and north-facing modules should be avoided (north-facing modules produce ~15% less compared to south-facing). Solar curtain walls produce a decreased amount of energy, due to their vertical positionality. A solar wall will still help a building reach NZE and therefore provide energy and cost savings to occupants. The largest solar carport installations, in California, generate 7.7 and 8.7 MW of electricity. Standalone solar EV charging stations can be found in Boulder and generate 16 kWh/day.

03. Durability

Solar panels are the best option, as flexible panels do not provide as much energy and do not last as long. Most solar panels can withstand winds up to 140mph. During the hail storm of 2017, NREL found that only one of the 3000+ panels was broken during the storm. Panels are only getting stronger and more durable thanks to extensive tests through Sunshot.

SOLAR INSTALLATIONS & FACADE

04. Cost

- A residential solar awning can cost between $5,000 and $14,000. Solar canopies can cost ~$35/sq. ft.
- The cost for solar curtain walls is highly variable; information on cost is lacking because it is a fairly new practice. Much more expensive than rooftop solar, solar curtain walls are only cost-effective in new constructions when the external façade or wall of the building can be substituted for the solar modules, and therefore eliminated from the build.
- Solar carports cost ~$3.45/watt. Solar EV charging stations cost $65,000 but can provide savings of $40,000-$80,000 in electricity costs over 20 years.

05. Location Considerations

- Solar awnings can be scattered throughout the development as needed to meet NZE. They can be placed over windows and entrances/exits to buildings. Solar pergolas should be placed by the dog park and playground areas to provide shade.
- Solar façades should be installed on the south or southeastern side of a building. This can be the senior housing or south-most multifamily building. It cannot be shaded by other buildings or trees.
- Solar carports and charging stations can be installed by the multifamily carports.

06. Case Studies

Solar awnings, overhangs:

- Integrated Power Systems (IPS) has completed many local residential projects incorporating unique designs. IPS has also completed a custom solar awning for UCAR and for Pharmaca, both in Boulder.

Solar façades or curtain walls:

- Boulder Commons includes 205 kW of solar façade from IPS and a small experimental solar window. The NZE development is made up of apartments and commercial office spaces.
- In Germany, the Blauhaus is a mixed-use educational facility that is energy efficient and meets Passive House standards.

Solar carports and EV charging stations:

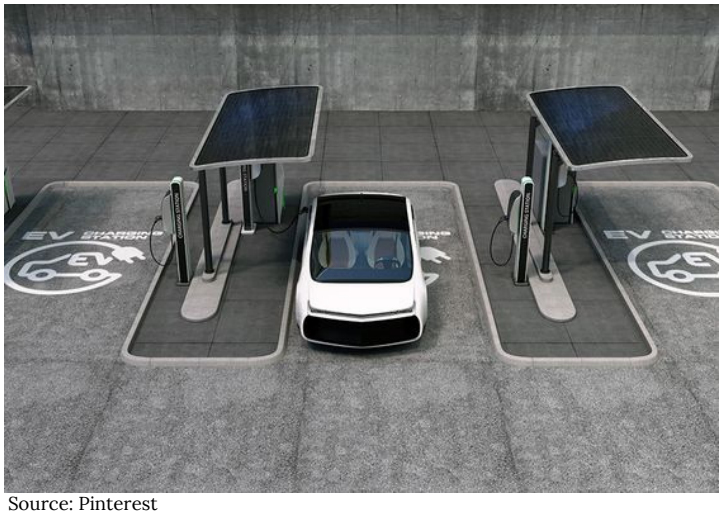
- There are several solar carport installations around Boulder/Denver done by Namaste Solar, such as the Unico/City of Boulder Parking Garages, Denver Water, and Peña Station at DIA.
- Beam Global installed solar EV charging stations in New York City.

SOLAR INSTALLATIONS & FACADE

07. Additional Resources

- *Solar curtain wall*
- *Solar Carports*
- *Durability*: *Hail durability*, *International PV Quality Assurance Task Force*.
- *Cost*: *Solar carports*, *Solar canopies.*
- C-PACE
- PVWatts *to estimate general needed kW DC of installed solar to get to NZE*
- Independent Power Systems (IPS)
- Namaste Solar
- Titan Carports
- Beam Global

Professional Contributors: **Norris Design, HB&A**


Source: Pinterest


Source: Pinterest


Source: Pinterest


Source: Pinterest

AGRIVOLTAICS

Agrivoltaics can not only provide one solution for two very land-expensive activities–crop production and power generation–but has a wealth of other benefits, as detailed below:

- Water conservation: Panels reduce evaporation of water in the soil through shading. Native plants in pollinator gardens also require reduced watering.
- Soil health: Native plants stabilize soil and more efficiently capture and store carbon dioxide, (through carbon sequestration) thus contributing to the reduction of GHGs.
- Increased crop production: Crops are proven to produce more yield due to a slightly reduced temperature and reduced photosynthetically active radiation under the panels. Panels also protect crops from harsh weather and storms.
- Biodiversity and healthy ecosystems: Pollinator gardens create healthier soil and crops and contribute to improved biodiversity of a region by bringing other species to the area.
- Economy: Financial savings from combining two significant uses of land can be reinvested into the economy while providing double the benefit to society.
- Resilience: Contributes to energy security and drought tolerance

01. Types of Agrivoltaics

There are three types of agrivoltaics: pollinator planting, crop production, and grazing. Pollinator and crop production will be beneficial to Willoughby Corner, as the site lacks adequate space and conditions for grazing animals.

- Pollinator planting can cultivate a beneficial environment for native plants and pollinator species, increasing the health of regional soils, crops, and general plant growth and biodiversity, especially paired with crop production
- Crop production requires careful consideration of crop type (shade/water needs) to be planted beneath the panels. Crops that best suit agrivoltaics are tomatoes, peppers, and grapes, which thrive in the shade from the panels.
- Livestock grazing requires vast open space, and thus is not possible for the site

02. Cost

Agrivoltaics is relatively new, therefore there is little to no documentation for cost.

03. Location Considerations

The multi-use lawn by the playground would be the most ideal site for a small agrivoltaics installation. Additional site analysis and possibly an environmental impact report should be conducted prior to installing the project.

- Due to the close proximity to the ground, and the risk of equipment damage or human injury, the installation would likely need to be fenced off. Community staff can provide access through a rentable key to residents. Residents would need to be trained on safety before getting access to care for this garden.

AGRIVOLTAICS

04. Case Studies & Contributors

The Colorado Agrivoltaics Learning Center is a nonprofit partnering with Jack's Solar Garden to educate the community about the benefits of agrivoltaics.
Agrivoltaics projects in Colorado:

- Solinator Garden: pollinator garden by Namaste Solar and Solaris Energy
- NextEra at IBM Boulder: pollinator garden by Namaste Solar
- CSU Horticulture Research Center: research garden by Sandbox Solar
- Jack's Solar Garden, LLC: community solar garden in Boulder County for agrivoltaics research. The farm went through a long permitting process to all but created a new type of permit for agrivoltaic operations. It is a 1.2 MW community solar garden that has many subscribers to not only purchase renewable energy, but hosts partners to grow crops and pollinator gardens on the farm. Subscribers include Terrapin Care Station, In the Flow Boutique Cannabis, Western Disposal Services, Meati, etc. Partners include CSU, NREL, Sprout City Farms, Audubon of the Rockies, and more.

Professional Contributors: **Norris Design, HB&A**

05. Additional Resources

- *Benefits of Agrivoltaics*: *Springer Nature*, *NREL*
- *Colorado Agrivoltaics Learning Center*
- *C-PACE*
- *Namaste Solar*
- *Colorado Agrivoltiacs Learning Center*


Source: Pinterest


Source: Pinterest


Source: Pinterest

EV CHARGING STATIONS

EVs continue to gain traction among drivers in Colorado and Boulder County. As such, it is imperative that residents living in Willoughby Corner have access to charging stations. Abundant EV charging stations will ensure that drivers can continuously rely on their EVs. Moreover, they may appeal to residents who are considering transitioning to an EV.

01. Cost Considerations

ChargePoint has funding resources that will help to fund installation of chargers, either through the Charge Ahead Colorado or Xcel Energy.

02. Location & ADA/Handicap Considerations

Parking considerations must be made to accommodate all riders. As such, ensure there is a balance between equitable accessibility parking and access to EV chargers near building entrances.

03. Sizing Demand

Special considerations should be given to estimating the number of EV chargers needed in the community. Since EV adoption is expected to increase through the near future, the number of chargers should be adequately assessed in the early stages of planning and development. Integrating additional charging stations in the future may create challenges once the parking has been developed. Consider how much parking is currently estimated and if there are any surplus parking spots.

04. Solar Car Ports

Integrating solar energy into parking lots would be a great way to introduce resilience for EV stations as well as providing shelter and environmental benefits. Willoughby Corner can increase its solar generation and encourage others to drive EVs with solar car port technology.

EV CHARGING STATIONS

05. Case Study & Contributors

- *Denver EV Infrastructure*
  - Denver's Office of Climate Action, Sustainability and Resiliency (CASR) announced the addition of seven electric car share vehicles into six under-resourced communities in Denver, and subsidized memberships for at least 450 residents in these areas.

Professional Contributors: **Boulder County Mobility for All, HB&A, Farnsworth**

06. Additional Resources

- *Federal Funding Programs for EV Charging*
- *Lafayette EV Charging Station Data*
- *Public Charging Guide*
- *EV Charging Best Practices*
- *Solar Car Ports*

Source: Pinterest

Source: Pinterest

Source: Pinterest

Source: Pinterest

DISPERSED BIKE STORAGE & KIOSKS

Bike transportation offers freedom and flexibility as a low-cost transit option for community members, allowing for greater access to town amenities and local services. By dispersing bike kiosks throughout Willoughby Corner, residents across the community will have easy access to bike storage and/or rental options. Due to the diverse range of residents' ages and families living at the complex, additional storage for trailers/trolleys should be dispersed throughout the community. Mail and bulletin kiosks offer ways to tailor design considerations and increase a sense of community while still providing necessary services for residents.

01. Cost Considerations

If BCHA chooses to build Bike-n-Ride shelters within the community, there is a much higher cost associated with this option compared to building complex-specific bike shelters (i.e., connecting to the entire Boulder County Bike-n-Ride network vs pin-code entry shelters)

02. Sizing/Estimating Storage Demand

Since Willoughby Corner will be completed in phases, sizing the demand for bike storage should be assessed from the beginning to accommodate all residents in the future. Larger items, such as bicycle trailers, can increase storage capacity as needed.

03. Potential Partnerships & Contributors

Developing partnerships can increase options for micromobility in addition to bike storage. This allows for local bike transit for residents who may not own bicycles and provides a low-cost alternative. Local case studies are highlighted below.

- *Exploring B-Cycle in Boulder County*
  - Louisville-based Community Solutions received a $66,000 grant from the Denver Regional Council of Governments to explore the feasibility of bringing Boulder B-Cycle to Longmont, Erie, Lafayette, Superior, Louisville, and Broomfield.
- *Denver's Scooter & Bike Share Program*
  - Lyft and Lime are partnered with the City of Denver and include equity-based pricing programs.

Professional Contributors: **Mobility for All, HB&A, Boulder County Community Planning & Permitting**

DISPERSED BIKE STORAGE & KIOSKS

04. Security

Adequate security should be implemented into all storage units across the complex, as well as ensuring lighting in the area and/or security cameras.

05. Location Considerations

Located throughout the complex, heavily concentrated near the mobility hub.

06. Additional Resources

- *Bike Share Implementation Strategies*
- *Boulder County Bike-n-Ride Shelters*
- *Multi-Family Bike Storage Options*
- *Mail Kiosk Best Practices*

Source: Pinterest

Source: Pinterest

Source: Pinterest

Source: Pinterest

BUS STOP INFRASTRUCTURE

Bus stops are places that are the “in-between” of getting from point A to point B and are typically uncomfortable or generally unpleasant. With the bus stops on site, it is an opportunity to alter the above narrative and make the bus-stop an enjoyable and welcoming place for the community. This essential amenity should have anti-hostile architecture, weather informed design to create optimal comfort and, ideally, set a new precedent for bus stops.

01. Cost Considerations

The average RTD bus stop, which follows “traditional” bus stop infrastructure design varies in pricing, depending on location but can be anywhere from $5,000-10,000. This stop, with its additional features, has the potential to exceed the average price range as it will have additional features, such as bike storage, high quality glass and recycled plastic seating.

02. Mobility Storage

Additional space is needed for bike/e-bike and skateboard storage, which will limit the amount of seating available.

03. Materials

Having high quality glass reduces thermal discomfort from the sun but may impose additional costs. Ideally, local and recycled materials could be utilized. However, it may be challenging to source sustainable materials for the internal structure (i.e., plastic seating) due to increased costs or inability to source locally.

04. Case Study & Contributors

- *America's Best Bus Stops, Multiple Locations*
  - The best bus-stops follow the rule of breaking the standard mold of bus stop infrastructure. This can be showcased in various forms, such as incorporation of art within or around the physical structure, comfortable seating, bilingual signage, vibrant colors, as well as having a well-lit surrounding environment.

Professional Contributors: **Mobility for All, HB&A, and KH, RTD**

BUS STOP INFRASTRUCTURE

05. Additional Resources

- *Seating*
- *RTD Bus Infrastructure Design Guidelines & Criteria*
- *From Sorry to Superb – Everything You Need to Know About Great Bus Stops*
- *What is hostile architecture?*
- *What Makes A Bus Stop Great?*

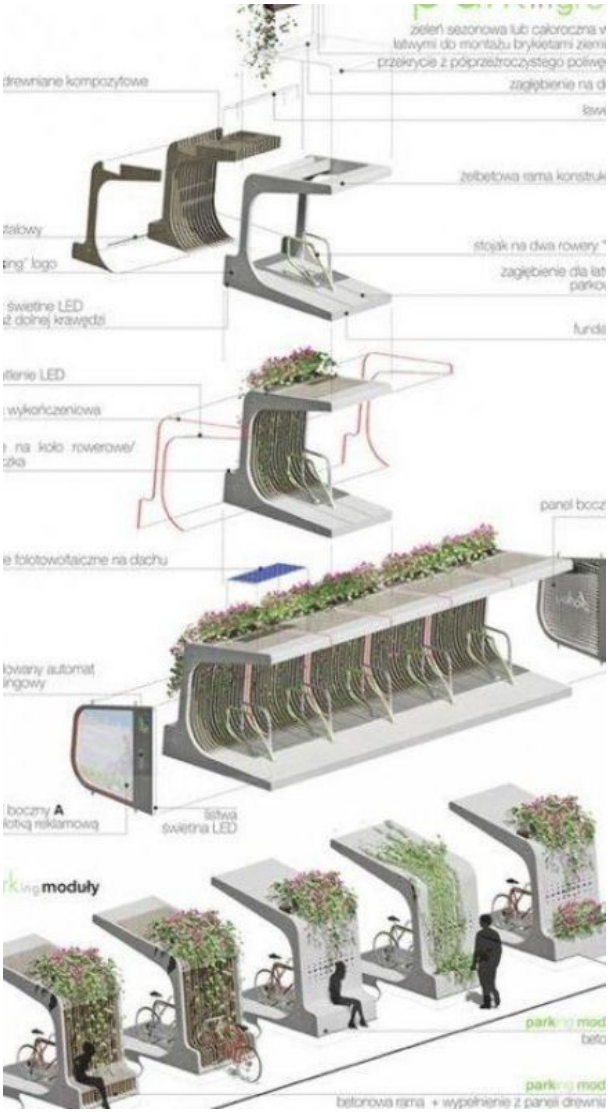


Photo sources: Pinterest

SITE LIGHTING

Site lighting enables the safe use of outdoor spaces such as utilizing biking and walking paths in the evening and early morning or enjoying outdoor gatherings once the sun goes down. There are also opportunities to install creative lighting arrangements that enhance the overall aesthetics of the site. Since Willoughby Corner will include many outdoor spaces such as community gardens and a dog park, there are opportunities to integrate various light features throughout the site that create a safer and more comfortable environment for residents of all ages to enjoy, no matter what time of the day.

01. Light Pollution

Lighting should shine on/in areas that are needed to avoid additional light pollution. For example, shielded light fixtures and downward lighting ensure that walkways are lit without shining upwards to the sky or outwards.

02. Wildlife

Lighting can negatively affect wildlife such as disorienting animals or deter wildlife from entering certain areas.

03. Motion Activated Lighting

Motion sensors allow for the activation of lighting only when needed. This is effective for energy conservation and avoiding additional light pollution. No-touch lighting options can also be more accessible for elderly and disabled residents. However, the maintenance could be a potential challenge, and some areas may need to be consistently lit for safety reasons.

04. Location Considerations

- Outdoor lighting will likely be placed throughout the site. Some priority locations include:
  - Adequate lighting around the senior building to increase accessibility (i.e., lighting on stair steps and handrails)
  - Ample lighting along walking and biking paths to encourage use and enhance safety
  - Prioritize lighting in the garden areas, particularly along walking paths and near benches residents may use
  - Lighting at bus stops, bike storage, mail kiosks, etc. – again for safety and usability

SITE LIGHTING

05. Integrated Photovoltaics

Source: Solar & Lighting

Integrating solar power in site lighting can provide energy savings and sustainable options within the community. For example, there are new designs with integrated solar pole lighting with a vertical PV module, which help reduce snow or dust buildup on the module (see left image). Additionally, Soltech has a solar LED bollard light with a smart solar tracking system and a round shape to avoid dust buildup (see below image).

06. Case Study & Contributors

- Wildlife Lighting Criteria, Florida Fish and Wildlife
  - Florida F&W creates its own criteria for lighting that is wildlife 'friendly.' The requirements are similar to Dark Sky criteria but are tailored to the specific wildlife in Florida. Similar considerations could be integrated into Willoughby Corner's lighting guidelines.

Professional Contributors: **Norris Design, HB&A, and Farnsworth, City of Lafayette**

07. Additional Resources

- *Dark Sky Friendly Home Lighting Program*
- *Motion Sensor Lighting Pros and Cons, Beacon Home Services*
- *Solar LED Bollard Lighting by SUNDIAL*
- *Integrated Solar Pole Light with Vertical PV Module*
- *Solar Step Lights*

Source: Home Depot

Source: Solartech

Source: Tim Hunt, Lighting Designer

ART INSTALLATIONS

Art is an opportunity to showcase the unique character of a city or neighborhood and display local artists' work. Additionally, art contributes to placemaking and building a sense of community while providing positive mental health benefits, especially for senior residents. There are various ways to involve community members in creating or selecting specific art included in the community, such as voting on the theme of a proposed art installation.

01. Community Art Projects

Residents can engage in art activities, such as painted walking paths, pedestrian crossings, and other paths/roadways as not only an art installation, but also a traffic calming technique. Paint can be a low-cost addition to other traffic calming and safety measures, such as protected bike paths or other barriers between pedestrian spaces and cars.

Painted murals on traffic boxes and other structures can discourage graffiti and transform an eyesore object into an art installation. However, the community must consider if these art features are allowed and potentially establish a partnership with the local Public Art Committee.

Using QR codes and other interactive signage can credit artists and create an "art walk" for residents and visitors.

02. Cost Considerations

Art projects can be relatively low cost, especially if recycled materials are used (see bottle cap example included below). A partnership with the Public Art Committee could help fund commissioned art by local artists.

03. Location Considerations

- Bike kiosks/bike storage facilities if applicable
- Painted crosswalks
- Community/mixed-use space wall mural
- Senior and multifamily building wall murals
- Traffic/switchgear boxes
- Sculptures in the 'hot dog' park
- Sculptures and other art integrated along multi-use path

Source: Pinterest

ART INSTALLATIONS

03. Case Study & Contributors

- Longmont Art in Public Places, "Shock Art"
  - Shock Art is a project organized by Longmont's Community Services Department that paints green switchgear boxes with the help of local artists and community-wide voting.
- Boulder Commons
- Community Housing Partners, Baltimore

Professional Contributors: **Norris Design, Farnsworth, HB&A, City of Lafayette, ELAC**

04. Additional Resources

- *The Connection Between Art, Healing, and Public Health: A Review of Current Literature*
- *Longmont Art in Public Places – Community Services Department*
- *Lafayette Arts and Cultural Resources Department*
- *Lafayette Public Art Committee*
- *The Edible Hut – Detroit, MI*
- *Bottle Cap Mural Project*
- *Centennial, CO - Traffic Box Wrap Pilot*
- *Tacoma, WA and Olympia, WA*
- *Moss Wall Art (indoor):* *Artisan Moss*, *Planthropy*

Source: Startt, WHATAMI

Source: Pinterest

Source: Pinterest

Source: Pinterest

SITE SIGNAGE

The intersections of site signage, placemaking, and interpretation allow for connectivity between Willoughby Corner and the larger community. Moreover, aesthetic considerations can contribute to a psychological sense of well-being and visual unity with the surrounding environment.

01. Inclusive and Interpretive Design

Providing multilingual and Braille/touch elements can enhance inclusiveness within the community. Moreover, by integrating a variety of textures and storytelling elements in signage, it can connect an individual to the history of a place or explain the meaning of a theme/concept (i.e., near art installations, native plant gardens, or along recreation trails).

02. Environmental Placemaking

Integrate static and digital channels to promote connections to nature. This may include QR codes on plant identification signs or "scavenger hunt" signage in parks/along trails to identify the local flora and fauna.

03. Wayfinding and Connectivity

Wayfinding can highlight landmarks in the surrounding community and provide distances/estimated commute times based on the method of mobility (walking, biking, etc.)

04. Materials

Challenges: While local is always the optimal choice for sustainable materials due to the reduction in embodied carbon impacts, it is not always feasible if local vendors do not provide adequate options.

Solar power custom signage can provide sustainable illumination for the community's monument sign, or presenting information near bus infrastructure.

Green wall signage can improve the thermal performance of a building by creating shade and an air space between the plants and the building; mitigate stormwater runoff; reduce noise; break up the urban landscape of concrete, glass, and steel; and absorbs carbon dioxide. This could either consist of a self-sufficient system that uses specialized membranes, panels, and modules to support the plants, OR a green facade that uses plants that grow up a supported trellis and have roots in the ground.

SITE SIGNAGE

05. Location Considerations & Contributors

- Trails & parks (emphasis on environmental placemaking and wayfinding)
- Near bus infrastructure/mobility hubs
- Plazas and Community Connection Points → understanding circulation paths, entry points, and other logical points based on high foot traffic (consider how community members will interact with the development based on the location of other amenities throughout the community; provide signage to direct community members to these amenities).
- Native plant walls on custom substrates with low-cost, sustainable signage that directs community members to amenities throughout the site

Professional Contributors: **Norris Design, Farnsworth, HB&A**

06. Additional Resources

- *Illuminated Signs: Solar & LED Sign System*

Source: *Pinterest*

Source: *Pinterest*

Source: *Pinterest*

Source: *Pinterest*

Source: IDS

COMMUNITY GARDENS, LANDSCAPING, & PLAZA FEATURES

Community gardens allow for local food production, promote a sense of community and unity, allow for "farm-to-table" dinner events, and provide an opportunity to connect community members to their food. Landscaping, plaza, and trail features all contribute to placemaking and invite community members to interact with nature and one another.

01. Accessible Community Gardens

- ADA-friendly community boxes that allow wheelchair users to garden.
- Native seed banks and community programming allows for the genetic preservation of native seeds while optimizing crops due to climate suitability. Community programming can enhance the sense of community while ensuring routine maintenance within the gardens.
- *Partnership Opportunities*: ***Denver Urban Garden Collaborative (DUG)*** collaborates with many municipalities on the Front Range; this could provide an opportunity to link Lafayette to DUG's collaborative model to optimize seed sharing, community programming, climate considerations, etc.

02. Landscaping

- Xeriscaping and native plants will reduce irrigation needs while still integrating native biodiversity (review ***Colorado Front Range Native Plant List***).
- Provide shading throughout the recreation trail and community spaces so transit users have thermal comfort while commuting.

03. Plaza Features

- Solar powered benches from IDS can provide community Wi-Fi and seat lighting for nighttime use. They also allow individuals to charge devices outside in community spaces.
- The solar eye trail from IDS creates sustainable and subtle lighting for bicyclists and pedestrians commuting on trails at night.

COMMUNITY GARDENS, LANDSCAPING, & PLAZA FEATURES

04. Location Considerations & Contributors

- ADA community garden boxes located around the senior building for accessibility
- Swinging benches overlooking the flatirons or other notable landscape features, if possible
- Emphasize shading around bus infrastructure and along the trail to bus stops, especially for residents who are susceptible to extreme heat illnesses
- Pocket parks with native plant displays in outlets → add benches for "zen" gardens

Professional Contributors: **Norris Design, KH, HB&A, ELAC**

05. Additional Resources

- *Solar Smart Benches from IDS*
- *ADA Community Garden Boxes* (*$395.99 from this vendor*)
- *Community Seed Network*
- *What's in Season in Colorado? A Monthly Fruit and Veggie Guide*

Source: *Pinterest*

IDS solar Wi-Fi bench

Source: *Pinterest*

Source: *Front Range & Foothills Native Plants*

PLAYGROUNDS, DOG PARKS, RECREATION TRAILS, & ORCHARDS

Playgrounds, dog parks, recreation trails, and orchards provide residents with ways to socialize and stay active. Many of these features are a non-negotiable of what needs to be included in communities and also help create a sense of community. These features can be used by people of all ages and can also serve as locations for potential community programs and events.

01. Playground

- Given the amount of foot traffic and time spent at them shaded areas with seating, bathrooms, and water close provide a better experience for all
- ADA friendly features allow those with disabilities to use the facilities as well
- Small shelters like teepees, coves, tunnels to provide shade in the playground
- Include art features that can be done by the community to create a sense of belonging

02. Dog Park

- Design with humans in mind to also make their experience positive
- Have shaded areas, bathrooms, and water close by
- Good in-and-out system for dogs
- Seating area inside, preferably shaded, for dog owners
- Adjacent dog park for small dogs only

03. Recreation Trail

Recreation trails allow the community to stay active. Therefore, it's important to make these accessible and functional to all. Separate lanes for pedestrians and bikers can ensure ease of use and a smooth trail surface allows for people with a different range of abilities to use it.

04. Orchards

- Use drip irrigation for controlled water release and the potential to save water
- Use plants that are drought tolerant (e.g. pomegranate, persimmon, fig)
- Include a seed library, pond, and/or rock garden
- Include a multi-use space area for grilling, picnics, and potential programs

PLAYGROUNDS, DOG PARKS, RECREATION TRAILS, & ORCHARDS

05. Location Considerations

- Locate orchard in a shaded or sunny area based on the plants being used; ensure the location has appropriate soil conditions and soil depth
- Have multiple points of entry and exit to the recreation trail
- Provide appropriate lighting to allow night time use

Professional Contributors: **Norris Design, KH, HB&A, ELAC**

06. Additional Resources

- *Designing and Managing Innovative Dog Parks*
- *Natural Playgrounds*
  - *City Park*
  - *Washington Park*
- *Planning and Designing an Orchard*
- *Recreation Trail Design*

Source: Wayward

Source: megagrass

Source: Earthscape

Source: City of Boulder

SUSTAINABLE MATERIALS

The vision for Willoughby Corner emphasizes sustainable design considerations throughout the community's features. To reduce environmental impacts and embodied carbon within construction materials, we recommend selecting products that promote circularity (cradle-to-cradle lifecycles), locality, and minimize waste. Refer to the resource section for additional information.

01. Solid Surfaces

- **Best solid surfaces products include:**
  - Meet CDPH Standard Method emissions requirements
  - Are made from natural stone and are certified to ANSI/NSC 373 and/or C2C Silver or higher
  - Are composite surfaces that contain 100% post-consumer-recycled content or FSC-certified content
  - Are glass composite surfaces with high recycled content and no epoxy
  - Are engineered stone/quartz that have NSF/ANSI 51 food contact safety certification and contain post-consumer recycled materials or have other environmental benefits
  - Are FSC-certified wood, sustainably reclaimed wood, or made of rapidly renewable bamboo
- **Avoid products that include:**
  - Composite products or coatings that contain epoxy
  - Products that do not meet the durability requirements of the application
  - Products that use per- and polyfluoroalkyl substances (PFAS) surface treatments
  - Avoid wood products that do not come from sustainably managed forests
  - Products that contain antimicrobials (engineered stone/quartz)
  - Acrylic and polyester solid surfaces

02. Certifications, Documentation, and Contributors

- **Certifications & Documentation**
  - Cradle to Cradle Silver or Gold
  - ANSI/NSC 373: Sustainable Production of Natural Dimension Stone
  - Greenguard Gold
  - Forest Stewardship Council Certification
  - HPD
  - Declare

Professional Contributors: **HB&A, Group 14**

RECOMMENDED PRIORITIES

From our research, we identified overarching recommendations for strategies that could be prioritized in future planning for Willoughby Corner and other BCHA housing developments. We believe that prioritizing these elements will contribute to a more resilient, connected, and sustainable community for Willoughby Corner's residents. While this report presents a wide variety of options, we determined that the list below will be the most impactful and potentially feasible.

01

Thoughtful and creative bus stop design

Creating an inviting, comfortable space for residents to use with the following considerations:

- Anti-hostile architecture
- Thermal comfort considerations
- Comfortable, inviting space
- Integrating community bulletin boards and artwork

02

Emphasize accessible and inclusive design features

Ensuring that amenities are accessible for all residents including:

- ADA friendly planter boxes and picnic tables
- Community table in the garden to encourage farm to table meals
- Wayfinding trail signs in multiple languages, including braille

03

Solar Integrated Infrastructure

Installing solar integrated infrastructure to contribute to grid resilience and energy security. This could include the following:

- Solar signage
- Solar lighting systems
- Solar carports
- Solar-powered EV charging stations
- Solar pergolas and benches in outdoor community spaces

04

Incorporate and prioritize drought tolerant and native landscaping

As the climate continues to change, it is necessary to incorporate drought tolerant and native landscaping to reduce water use. Other reasons include:

- Creating native pollinator habitat
- Less maintenace

CONCLUSION

Across the front range, rent prices are increasing and it is becoming increasingly difficult for individuals and families to secure affordable housing. The City of Lafayette, Boulder County, and BCHA partnered to purchase the location for Willoughby Corner, which was once a vacant industrial-zoned location. Willoughby Corner will help not only the City of Lafayette address the lack of housing affordability but it will also set an example for years to come about the possibilities and necessity of affordable housing across the Front Range and beyond. While many of the recommendations and considerations were specific to Willoughby Corner, these topics and designs can be applied broadly to other BCHA developments and beyond.

The recommendations throughout this report were created in collaboration with University of Colorado Boulder Masters of the Environment graduate students and BCHA. The graduate student team brought a multi-disciplinary approach to varying topics with an emphasis on inclusivity and resilience in the face of climate change.

Our team would like to thank our partners at BCHA for supporting this project and all the project consultants who provided their time and feedback.

Renderings of Willoughby Corner provided by HB&A

RESOURCES

Sustainable Materials Resources

- **Product Guide for LEED Projects** – Need a Design Page premium membership but can access sustainable and recycled products for sustainable development projects.
- **BuildingGreen** – This website is for LEED professionals. There is a lot of great information regarding sustainable materials, what to look for, what to avoid, etc.
- **BetterMaterials** – Meta database that allows you to filter for sustainable products (can filter for LEED products, for example, even though we are not becoming officially certified). Products are becoming Green Business Certified through the GBCI to ensure compliance.
- **BIFMA Level** – Level certified furniture can be found in this database. You can filter for USGBC compliance for optimal sustainable results.
- **C2C Product Registry** – Cradle-to-Cradle certified products – have disclosure and optimization of material ingredients for sustainability.
- **Declare** – Look for products that are labeled for the International Living Future Institution's Declare program. Filter results for LEED compliance or look for Red List Free Declare labels.
- **Ecomedes** – Search tool that has elaborate LEED filters, including products for energy, water, BPDO, and low-emitting materials.
- **HPD Repository** – Filter for LEED materials.
- **Origin/Mindful Materials** – Similar to Ecomeds, summarizes data from a variety of other databases to present products with a large variety of sustainability certifications.
- **SCS Certified Green Products Guide** – Provides materials with a variety of documentation verified by SCS Global, including low emitting materials, recycled content, material ingredients disclosure, etc.
- **Spot** – Provides a unique "nutrition fact" label for sustainability attributes in products. Includes EPDs, Level, Cradle to Cradle, and UL's Greenguard Gold Certification for low-emitting materials.
- **Sustainable Minds Transparency Catalog** – Similar to ecomeds and origin, gathers data from a variety of sources and can filter for LEED.
- **Green Rebuild Toolkit** - Natural fire-resistant building materials (mudbrick, strawbale, recycled concrete, rammed earth, hempcrete, timbercrete, etc.).

RESOURCES

Recycled Materials Resources

- **Recycled Material Equipment/Items/Materials** can be sourced from **Design Pages** (need a premium account to access collections)
- **Reuse Ecosystem Map**: Provides a map that connects design teams with construction industries that promote an inclusive, circular economy. Includes reuse, deconstruction, hauling/warehouse, government/public agency, network/resources, remanufacturing/recycling, training/education, and consulting/research opportunities.

Local Opportunities for Recycled Materials:

- **Perks Deconstruction -** 6145 Broadway - Denver, CO (destruction and salvaging)
- **Recycle Colorado -** 1536 Wynkoop St - Denver, CO (network/resources)
- **Resource Central - Materials Reuse and Tool Library -** 6400 Arapahoe Rd - Boulder, CO (reuse)
- **Art Parts Creative Reuse Center -** 3080 Valmont Rd - Boulder, CO (reuse)
- **Habitat ReStore - Boulder County -** 6650 W 120th Ave - Broomfield, CO (reuse)
- **Habitat ReStore - Denver -** 70 Rio Grande Blvd - Denver, CO
- **RecCreative Denver -** 765 Sante Fe Dr - Denver, CO (reuse)
- **Gone for Good -** 101 Kalamath St - Denver, CO (hauling/warehouse)
- **Colorado Demolition and Deconstruction -** 16512 Gilpin St - Thornton, CO (Deconstruction/salvaging)
- **Hillen Corporation -** 7600 Dahlia St - Commerce City, CO (reuse)
- **Queen City Architectural Salvage -** 4750 Brighton Blvd - Denver, CO (reuse)
- **Deconstruction Colorado - (**address n/a; deconstruction/salvaging)
- **National Center for Craftsmanship -** 1414 Blue Spruce Dr - Fort Collin, CO (training/education)

RESOURCES

Fire Resistant Materials Resources

- **Elemental Green** - Provides an overview of sustainable and fire-resistant materials for home construction.
  - Fungi
  - Mass Timber
  - Rammed Earth
  - Straw Bale
  - Stone
- **Innovative and Sustainable Flame Retardants in Building Construction and Materials** - Provides an overview of various flame retardant construction materials and additional treatment options to enhance resiliency. Refer to Table 14 below for an example of materials and applications that can be applied for fire retardants.
- **Colorado State FireWise Construction: Site Design and Building Materials** - Provides specific strategies for Colorado, including buffer zones within landscaping, building designs to reduce the spread of fires, and noncombustible materials. This document also includes a matrix of ignition-resistant materials on page 20.
- **Colorado Green Building Guild** - This NGO provides various resources for builders and Marshall-Fire impacted residents. Their resource page also includes energy smart guidance, passive house construction, a disaster assistance handbook, and more.

TABLE 14: FLAME RETARDANTS FOR THERMOSET COMPOSITES

Materials	Application	FR additives
Unsaturated Polyesters (UP)	Laminate structures, Pultruded profiles	ATH, APP, Intumescents, Phosphonate oligomers, DMPP, Various melamine derivatives
Vinylester (VE)	Laminate structures, Pultruded profiles	ATH, APP, Intumescents, Phosphonate oligomers, DMPP
Epoxy (EP)	Laminates, Panels, Adhesive layers, Tubes/pipes (filament winding)	ATH, AOH (boehmite), APP, Phosphonate oligomers, DOPO, Intumescents, Melamine phosphate, Melamine polyphosphate, Cyclic phosphonates, Phosphinates.
Polyurethane (PU)	Castings, Coatings, RIM parts	ATH, AOH (boehmite), APP, Phosphate esters, Phosphonate oligomers, Various melamine derivatives, Intumescents, Phosphorus Polyols, Alkyl phosphonates
Phenolics (PF)	Laminates and profiles	Excellent FST (fire, smoke, toxicity) performance without the use of FR additives. Sometime need addition of APP, Zinc borate, Melamine borate to improve smoke or suppress afterglow
Melamine resin (UF)	Laminates, wood particle boards	Excellent FST (fire, smoke, toxicity) performance without the use of FR additives.

Agricultural Programming Resources

- **Community Seed Network**
  - Provides a network of community seed programs; has a presence in CO

Local Opportunities:

Potential Partnerships

- *DUG (Denver Urban Gardens) Collaborative Model*
- **Service Based Partnerships**: Atlantis Community, Colorado Coalition for the Homeless, Denver Housing Authority, The Gathering Place, Mercy Housing, Metro CareRing
- **Faith-Based**: Denver Urban Ministries, Discovering Opportunities and Outreach for Reflection (DOOR), First Plymouth Church
- **Health-Based:** Clinica Tepeyac, Colorado School of Public Health at the University of Colorado Denver LiveWell Colorado, Tri-County Health Department
- **Youth- and Education-Based:** Adams County Head Start, Boys & Girls Club, Denver Public Schools, Mile High Youth Corps, Rangeview Library District
- **Municipalities:** Denver, Arvada, Aurora, Commerce City, Englewood, Edgewater, Golden, Lakewood, Littleton, Sheridan, Thornton, and Westminster -- potential to collaborate with Lafayette?
- **Benefits:** Collaborative models can assist with visioning, organization, and identifying skill development within the local community. Moreover, it promotes the development of steering committee models that organize volunteers and encourage mutually beneficial relationships with gardeners and the community.
- **Contact | Beauty Beyond Belief Wildflower Seed | BBB Seed**
  - Located in Boulder: 6595 Odell Pl, Boulder, CO 80301
  - Sells wide range of seeds: wildflower mixes, heirloom vegetables, grass mixes (grass and turf), and provide education on pollinators
- **Native Grass Seed Colorado - Arkansas Valley Seed (avseeds.com)**
  - Located in the Denver area (4300 Monaco Street Denver, CO 80216)
  - Provider of seeds to government agencies, municipalities, landscapers and more for reclamation projects and residential landscaping. They have a wide variety of warm and cool season grasses, wildflowers, shrubs, trees, wetland, and erosion control products.